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SYSTEM AND METHOD FOR REMOVING COATINGS FROM PLASTIC PARTS

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SYSTEM AND METHOD FOR REMOVING COATINGS FROM PLASTIC PARTS

Background of the Invention

The present invention concerns systems and methods for removing coatings from parts, and particularly from polymeric surfaces. The invention more specifically concerns systems and methods for removing paint from painted plastic parts.

There are many groups of products and associated processes in which polymeric materials, such as plastics, are coated with a material, such as paint. One such product group is automobile components, such as bumpers, grills and other plastic parts used in an automobile. As vehicle weight became an increasing concern, the automotive industry turned to plastic to help reduce overall vehicle weight. As part of this revolution, the traditional metal components were replaced with plastic equivalents for substantial weight reductions. The plastic bumper not only provides significant weight reduction, it does so with acceptable crash-worthiness, and even exhibits resilience during low-speed collisions. Another benefit of plastic components is the ability to paint the components to match the vehicle. While many metal components, such as bumpers or grills, had been chromed in the past, the chrome tended to flake off after only a few years. Plastic components readily accept the paints used to color the component so that a painted plastic component can hold its color for almost the entire useful life of the product.

While the affinity between polymeric surfaces and paint makes for a long-lasting painted part, this same characteristic poses problems for rejected parts. In some instances, a manufactured plastic part may be rejected after inspection for a number of reasons. For instance, a part is rejected when dirt or dust becomes embedded in the paint coating, or when the paint is not uniform across the entire part. By some estimates, reject rates can exceed 15% of the total part production for a typical plastic automotive component manufacturing process.

This scrap rate amounts to over three million pounds of rejected painted plastic parts every year, which represents enough plastic to leave the entire state of Indiana almost 2½ inches deep in plastic waste.

In accordance with most state environmental regulations, painted plastic parts constitute hazardous waste if sent to a landfill. Some manufacturers do send their scrap painted plastic parts to landfills, and some plastics are even disposed of illegally in spite of the best environmental enforcement efforts. Obviously, the great volume of scrap plastic parts represents an environmental and landfill crisis.

In order to alleviate this crisis, many companies have attempted to recycle or reclaim painted plastic parts. In the recycling approach, the entire plastic part is reduced to pellets that are sold as feedstock to plastics molding companies. The critical technology with this approach entails separating the plastic from the paint, as described in U.S. Patent No. 6,474,574. Of course, with this approach, the component is destroyed and loses substantial value when it is reduced to palletized feedstock.

In the reclamation approach, the purpose is to preserve the molded plastic component, such as a grill or bumper, and only remove the layer of paint. In one type of reclamation process, a painted bumper is subjected to high pressure jets of water and/or pre-heated air, as described in U.S. Patent No. 6,258,178. One significant problem with this process is that the high velocity and high pressure water jets can pit or damage the surface of the bumper. Surface roughness is a critical parameter to producing a uniform painted surface. The use of the high velocity water jet can yield a surface roughness that renders the processed part unacceptable for painting. This second rejection leads to recycling of the bumper plastic material.

In another reclamation approach, highly toxic chemicals are used to dissolve and strip the paint from the painted plastic part. One drawback of this approach is that it typically uses methylene chloride, which is highly regulated by the federal Environmental Protection Agency and by state environmental

agencies. The chemical itself is a hazardous waste that requires significant accommodations for safe handling and significant expense for safe disposal.

One other reclamation process involves running the scrap parts through a burn off oven. The oven temperatures are sufficiently high to burn the paint or other coating off the subject part without melting the part itself. This burning process leaves a potash residue that is also a hazardous waste. Moreover, the burning process creates defects in a certain percentage of the plastic parts sought to be reclaimed.

All of the above processes can be cost-prohibitive, especially for smaller producers of plastic parts, and most especially if the reclamation rates are not very high. There is a critical need for a system and process that can remove paint from plastic parts in a rapid, efficient and economic manner.

Summary of the Invention

In view of the foregoing substantial need, the present invention provides a system and method for effectively removing a layer of paint from a painted component, such as a polymeric or plastic part. In one aspect of the invention, a process is provided for removing a coating from a part that comprises the steps of immersing the part in a chemical bath contained within a process tank, the bath containing a first chemical solution effective to strip the coating from the part. While the part is immersed, the method calls for directing an aerated jet spray of a second chemical solution onto the part, the second chemical solution effective to strip the coating from the part. In the preferred embodiment, the first and second chemical solutions are the same chemical solution, which can be sodium hydroxide in a specific embodiment. The present invention permits the use of much less toxic chemical solutions than prior art techniques for stripping paint from plastic parts.

In a further feature of the inventive method, the chemical solution is heated above room temperature. In one embodiment, the solution is heated by flowing the solution through the chemical bath and through a recirculation path. A heater is interposed within the recirculation path and is controlled to maintain an effective temperature for the chemical solution. The recirculation path also preferably includes a filter for filtering material stripped from the process part.

In another aspect of the invention, the aerated jet spray of the chemical solution is directed in a direction transverse to the direction of recirculation of the solution through the chemical bath. Preferably, a plurality of spray nozzles are directed onto the process part from opposite sides of the process tank.

The invention also contemplates a system for removing a coating from a part, such as paint from a plastic part. The system comprises a tank having opposite side walls, opposite front and back walls between said side walls, a bottom wall and an open top with a lid adapted to close the open top. The tank defines a dip chamber configured to contain the chemical bath and sized to receive at least the part immersed within the chemical bath. Preferably, the tank

is sized to receive a plurality of such parts carried by a rack that is immersed in the bath through the open top.

In one aspect of the invention, the tank defines an inlet and an outlet at the opposite side walls of the tank. A fluid recirculation path is connected outside the tank between the outlet and the inlet and includes a pump for flowing the chemical solution through the chemical bath within the dip chamber. The recirculation path preferably includes a filter adapted to filter debris and materials removed from the process part. In addition, a heater is preferably interposed within the recirculation path to maintain the chemical solution and chemical bath at a predetermined temperature effective to enhance the ability of the chemical solution to strip the coating from the process part.

The tank further includes a plurality of spray nozzles supported on at least one of said front wall and said back wall of the tank, and most preferably on both walls. The spray nozzles are fluidly connectable to a source of the chemical solution. In one embodiment of the invention, the tank includes an outer tank and an inner tank nested within the outer tank and defining an interior cavity between the outer tank and the inner tank. The interior cavity includes insulation disposed between the inner tank and the outer tank. The tank includes a plumbing assembly disposed within the interior cavity, the plumbing assembly including the plurality of spray nozzles and at least one fluid inlet connectable to the source of the chemical solution.

The inventive system further includes an inlet tube in fluid communication with the plurality of spray nozzles, and including a fluid inlet connectable to the source of a chemical solution. An agitation pump is preferably provided to draw chemical solution from the source at a predetermined pressure and flow rate that is calibrated so that the spray jets can effectively strip the coating from the process part. In addition, a source of pressurized air connected to the inlet tube to aerate the chemical solution flowing into the inlet tube through the fluid inlet. A valve controls the pressure and flow rate of the pressurized air to optimize the size and quantity of air bubbles entrained within the jet spray of the chemical solution.

In an alternative embodiment of the system, a process tank is provided having opposite side walls, opposite front and back walls between the side walls, a bottom wall and an open top with a lid adapted to close the open top. The tank defines a dip chamber configured to contain a chemical bath and sized to receive at least the part immersed within the chemical bath. The tank further defines an inlet and an outlet at the opposite side walls of the tank, with a fluid recirculation path connected outside the tank between the outlet and the inlet and including a pump for flowing a chemical solution through the dip chamber. In one feature of this alternative embodiment, a plurality of impellers are mounted on the tank within the dip chamber, the impellers operable to generate a vortex in a chemical bath disposed within the dip chamber when a part is immersed therein. Preferably, the impellers are mounted on the underside of the lid so that the impellers are immersed within the chemical bath when the lid is closed over the tank.

The invention further contemplates a method for removing paint from the surface a plastic part comprising the steps of immersing the plastic part in a bath of a chemical solution adapted to remove paint from the surface of the plastic part, flowing the chemical solution in a first direction across the plastic part at a first flow rate, and impinging the plastic part with an aerated jet of the chemical solution in a second direction different from the first direction and at a second flow rate greater than the first flow rate.

One object of the present invention is to provide a system and method for removing a coating from a component that is efficient and that does not require the use of toxic or environmentally regulated chemical solutions. A more specific object is to provide such a system and method that can effectively remove a paint coating from the surface of a plastic part.

A broader objective is to reduce the amount of waste plastic parts that are created when a paint coating is deemed unacceptable. One benefit of the present invention is that the defective plastic part need not be scrapped or recycled by destroying the part. Instead, the present invention allows the part to

be, in effect, refurbished by removing the improper paint coating. Since the part itself is intact, it can be reused.

Another significant benefit of the invention is that the improperly coated part can be refurbished without the use of chemical solutions that are themselves regarded as hazardous by environmental regulatory agencies. With the present invention, much less toxic chemical solutions can be used that pose significantly less troublesome disposal problems than with prior paint removal techniques.

Other objects and benefits of the invention will become apparent upon consideration of the following written description taken together with the accompanying figures.

Brief Description of the Drawings

FIG. 1 is a top perspective view of a process tank in accordance with one embodiment of the present invention.

FIG. 2 is a side cut-away view of the process tank shown in **FIG. 1**.

FIG. 3 is a bottom perspective view of a plumbing assembly incorporated within the process tank shown in **FIGS. 1** and **2**.

FIG. 4 is a front view of the plumbing assembly shown in **FIG. 3**.

FIG. 5 is a front view of the inner tank back wall incorporated within the process tank shown in **FIGS. 1** and **2**.

FIG. 6 is a back view of the inner tank front wall of the process tank shown in **FIGS. 1** and **2**.

FIG. 7 is a side view of the inner tank side wall for the process tank shown in **FIGS. 1** and **2**.

FIG. 8 is a front view of the outer tank back wall included in the process tank shown in **FIGS. 1** and **2**.

FIG. 9 is an exploded side view a back wall support and a portion of the plumbing assembly mounted within the process tank shown in **FIGS. 1** and **2**.

FIG. 10 is a schematic representation of the nozzle system incorporated within the process tank shown in **FIGS. 1** and **2**.

FIG. 11 is a schematic representation of the process chemical flow circuit used with the process tank shown in **FIG. 1**.

FIG. 12 is a plan view of a process facility incorporating the process tank shown in **FIG. 1**.

FIG. 13 is a front perspective view of a process tank in an alternative embodiment of the present invention.

Description of the Preferred Embodiments

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same should be considered as illustrative and not restrictive in character. It is understood that only the preferred embodiments have been presented and that all changes, modifications and further applications that come within the spirit of the invention are desired to be protected.

The present invention contemplates a system and process for removing coatings, such as paint, from painted parts, and most particularly painted plastic parts. The invention contemplates dipping the parts to be treated in a chemical bath in which the chemical solution is heated and filtered and flows across the parts at a controllable rate. In addition, the invention contemplates impinging the coating with an aerated jet of the chemical solution. The flow rate and pressure of the aerated jet of chemical solution can be calibrated to the particular coating to be removed and the characteristics of the underlying plastic material.

In a preferred embodiment of the invention, a process tank **10** can be provided as shown in **FIG. 1**. The process tank defines a dip chamber **11** that is enclosed by a lid **12** mounted by hinges **14** so that the lid forms a tight seal with the body of the tank. The process tank **10**, and specifically the chamber **11**, is preferably sized to contain plastic parts carried on a submersible rack. In a specific embodiment, the process tank is configured to receive one or more painted plastic automobile components carried by a metal dip rack conveyed overhead. In a specific embodiment, the process tank can have a width of about 52 inches, a length of about 100 inches and a height of 60 inches to accommodate a dip rack carrying twenty average sized plastic automobile grills.

In the preferred embodiment, the process tank **10** is formed by an outer tank **16** and a nested inner tank **14**. All of the walls of the two tanks are offset from each other to provide an interior cavity **19**. The perimeter around the top of the two tanks **16**, **18** is sealed by seal plates **20** to close the cavity **19**. The seal plates **20** also provide a fluid-tight sealing surface against which the lid **12**

engages when the process tank **10** is in use. As described in more detail below, supports are provided between the outer tank and inner tank to support the inner tank within the outer tank and to maintain the interior cavity **19**. In the preferred embodiment, this space is filled with an insulating material (not shown) to help maintain an optimum temperature range within the dip chamber **11**. The insulation can be a high temperature fiberboard. In a specific embodiment, the outer tank **16** and inner tank **18** are sized relative to each other to maintain a spacing of about 3.5 inches for the interior cavity.

The process tank **10** is provided with end walls **22**. The end walls are configured to support inlet tubes **24** and outlet tubes **26** at opposite ends of the tank, as shown in **FIGS. 1** and **2**. It should be understood that the outer tank and the inner tank both include an end wall, with the two walls being similarly configured to support the particular inlet or outlet tube **24** or **26**. The tank further includes a back wall **30** that supports a number of vent tubes **28**. As will be described in more detail herein, the inlet and outlet tubes **24**, **26** provide a flow path for process chemicals to flow through the chamber **11** and across the parts being treated. This internal flow is necessary to wash away coating materials stripped from the surface of the process part. The vent tubes **28** vent any gas generated during the process and accounts for any overflow of the process chemicals within the tank **10**.

The back wall **30** also supports a plurality of nozzles **32**. The nozzles are connected to a source of air and a source of process chemical and are configured to produce a high pressure, high velocity aerated jet impinging on the painted surface of the part being processed. The front wall **34** is also provided with a similar array of nozzles **32**. In the illustrated embodiment, 120 nozzles are provided at 6 inch horizontal and 8 inch vertical intervals to maximize exposure of the processed parts to the effects of the aerated chemical jetting from the nozzles. The nozzles **32** can have a variety of configurations to produce a number of different spray patterns, such as flat, cone, spiral, rotating or hollow. The nozzles are preferably configured to keep air bubbles entrained within the liquid chemical jet until the jet strikes the process part. In addition, the nozzles

are preferably configured to provide a spray pattern that can be maintained when the jet is passing through the liquid chemicals flowing transversely to the spray path.

Referring now to **FIG. 2**, the interior features of the process tank **10** can be seen. The inner tank **18** includes a side wall **36**, a front wall **38** and a back wall **40**. The outer tank **16** includes similarly configured side walls (not seen), a front wall **44** and a back wall **46**. The interior cavity **19** is maintained between the outer and inner tank walls by a number of supports. For instance, side wall supports **50** are disposed between the inner tank side wall **36** and the outer tank side wall. Likewise, front wall supports **52** and back wall supports **54** separate the corresponding front and back walls **38, 44** and **40, 46**. The inner tank is supported above or offset from the base of the outer tank by a number of bottom wall supports **56** (see also **FIG. 1**). The number and thickness of the supports **50, 52, 54** and **56** are calibrated to support the weight of the process chemicals contained within the dip chamber **11**, as well as the weight of the inner tank. In a specific embodiment, the supports are spaced 14-16 inches apart, so that four supports are provided in the sides of the tank and seven supports are situated at the bottom, front and back walls. The supports are preferably 0.75 inch thick stainless steel panels.

Details of the walls of the tanks can be seen in **FIGS. 5-8**. As shown in **FIG. 5**, the back wall **40** of the inner tank includes a pair of openings **76** for receiving and supporting the vent tubes **76**. The openings and vent tubes can be welded or screwed together. The back wall also defines a plurality of nozzle openings **78** through which the nozzles **32** extend. Screw holes **80** near the upper edge of the back wall **40** and screw holes **84** near the bottom edge provide means for engaging the supports. The front wall **38** shown in **FIG. 6** is similar in construction to the back wall **40**, except that the vent tube openings are not necessary. The front wall **38** also includes a like plurality of nozzle openings **78** to receive the spray nozzles **32**.

Turning to **FIG. 7**, an exemplary side wall **36** is shown. The side wall includes screw holes **80**, **84** for mounting the side wall supports **50**. The side wall **38** also defines openings **82** for the inlet or outlet tubes **24** or **26** depending on which side of the tank the walls are located. The side walls of the outer tank are configured similar to the side wall **36** shown in **FIG. 7**, with additional height and width.

The back wall **46** of the outer tank **16** is shown in **FIG. 8**. The outer tank does not include any openings for the spray nozzles, since the nozzles are directed to the interior dip chamber **11**. Instead, the outer tank defines screw bores **84** for mounting the back wall supports **54**. In addition, the outer tank back wall **46** defines a pair of openings **76** for the vent tubes, like the back wall **40** of the inner tank **18**. However, unlike the inner tank back wall, the outer tank back wall **46** defines a second pair of openings **86** near the bottom of the wall. These openings accommodate inlets of the plumbing assembly **60** shown in **FIGS. 3-4**. In addition, the back wall **46** defines a pair of lift slots **88** at the bottom edge of the wall. These slots **88** permit forklift access to lift the entire process tank **10** when it is necessary to move the tank.

Turning back to **FIGS. 3-4**, details of the plumbing assembly **60** are shown. As can be appreciated from **FIG. 2**, the plumbing assembly resides within the interior cavity **19**. The perspective view of the assembly **60** shown in **FIG. 3** thus depicts the portion of the assembly that is situated within that cavity. The assembly includes a pair of tees **64** that define inlets **62** that are situated at the openings **86** in the back wall **46** of the outer tank **16**. One branch of the tees **64** each communicate with a corresponding transfer pipe **66** that runs along the bottom of the tank **10**, as shown in **FIG. 2**. The transfer pipes **66** are each connected to an elbow **68**. The other branch of the tees **64** communicate with vertically oriented tower pipes **70** situated at the back wall **30** of the tank. Likewise, the elbows **68** communicate with respective tower pipes **70** oriented at the front wall **34** of the tank **10**.

Disposed horizontally between corresponding tower pipes are a plurality of division pipes **72**. In the preferred embodiment, five such division pipes **72** are provided at both the front and the back walls of the tank, as shown in **FIGS. 2-4**. The nozzles **32** are connected to the division pipes to provide a spray exit for fluid traveling from the inlets **62**, through the tees **64**, transfer pipes **66** and elbows **68**, and up the tower pipes **70** to the division pipes **72**. As shown in **FIG. 2**, the tower pipes **70** are capped at a height below the vent tubes **28**. This arrangement accommodates chemical levels within the tank **10** that are just below the vent tubes **28**, while providing sufficient jet spray coverage for plastic components immersed in the chemical bath within the dip chamber **11**.

The division pipes **72** are supported within the interior cavity **19** by the front and back wall supports **52**, **54**, respectively. An exemplary back wall support **54** is shown in **FIG. 9**, with the understanding that the front wall supports **52** are similarly configured, although facing in the opposite direction to the back wall supports **54**. As shown in **FIG. 9**, the support **54** defines a number of notches **92** that are sized to snugly receive a corresponding division pipe **72**. A clamping block **94** is provided for each notch **92** and can be fastened to the support **54** by a pair of screws **95**. The clamping blocks **94** trap each division pipe within its corresponding notch **92** in the support.

Additional features of the plumbing system **60** are shown in **FIG. 10**, and particularly the components of the system that are exterior to the process tank **10**. A pressurized inlet tube **102** communicates with each inlet **62** of the plumbing system **60**. A nozzle **32** is schematically depicted as mounted within back wall **30**. Although this schematic representation suggests that the inlet tube **102** communicates directly with the nozzle **32**, it should be understood that the pressurized fluid is actually conveyed through the tower pipes **70** and division pipes **72** to each nozzle **32**.

The inlet tube **102** is fed chemical solution through the fluid inlet **104**. The solution can be pumped by an agitation pump **105** from a storage tank (not shown) at a flow rate that is calibrated to achieve an optimum jet spray for the

plastic parts within the dip chamber **11**. A check valve **106** provides access for compressed air to be injected into the inlet tube **102**. A compressed air source **114** feeds through a valve **108**. Flow through the valve **108** is adjusted by a controller **110** in response to a signal from a control signal generator **112**. In the preferred embodiment, the valve **108** is a solenoid valve, the controller **110** is a solenoid and the signal generator is a relay **112**. In one specific embodiment, the relay **112** is an on/off relay so that the solenoid **110** either opens or closes the valve **108**. Alternatively, the valve can be a variable flow valve to modulate the pressure and flow rate of the air provided by the source **114**. As with the chemical solution, the flow characteristics of the compressed air can be adjusted depending upon the nature of the part and the coating being processed.

In the preferred embodiment, the chemical solution is provided from the pump **105** to the pressurized inlet tube **102** at a flow rate of between 1 gpm and 500 gpm. This flow rate depends on several factors, including the material of the substrate, the coating to be removed, the temperature of the solution and its chemical make-up. For instance, on softer plastics, a lower flow rate may be preferable to avoid pitting the surface of the part. On the other hand, harder plastics, or plastics that are more elastic, can endure higher flow rates of the chemical jet spray. The proper flow rate for the pressurized chemical jet spray may require a testing phase where a new plastic material is encountered.

The air provided by the supply **114** is pressurized above the pressure of the chemical solution. Otherwise, the air will not be able to sufficiently enter the chemical flow and no air bubbles will be entrained in the chemical jet spray. This pressure can be between 1 psi and 250 psi, again calibrated with respect to the fluid agitation pump pressure. The air flow rate can be between 1 cfm and 100 cfm. The flow rate must also be calibrated to the fluid flow rate. Too little air flow results in too few air bubbles entrained within the jet spray, which unnecessarily lengthens the paint stripping process. Too much air and the fluid/air mixture is saturated with air bubbles. In this case, the air bubbles will combine with each other to form larger bubbles that are essentially incapable of providing the necessary abrasive effect. Other problems associated with incorrect air flow

rates include pump cavitation and the release of excess air into the working atmosphere. Again, the air flow rate must be calibrated to the chemical flow rate to produce optimum air bubble size and density for sufficient abrasive action as the entrained bubbles contact the part in process.

As explained above, the chemical solution also flows transversely through the dip chamber **11** from the inlet tubes **24** to the outlet tubes **26**. In the preferred embodiment, this flow is between 50 gpm and 500 gpm. The optimum cross-flow rate is largely a function of tank size. One function of this cross-flow is to circulate the solution through a circulation heater to control tank fluid temperature. Another function is to push dislodge coating material and other particles out of the dip chamber **11**. The flow rate necessary to achieve both functions is dictated by the size of the tank.

The chemical solution cross flow is maintained by additional external components of the plumbing system **60**, as shown in **FIG. 11**. In particular, the inlets **24** are connected to a circulation inlet tube **118**, while the outlets feed to a circulation outlet tube **120**. The discharged solution is fed through a filter assembly **122**, which can be in the form of a tower filter, which is operable to remove the coating material that has been stripped from the part in process. In the preferred embodiment, the filter assembly **122** is capable of filtering suspended solids down to 10 microns. In addition, the filter assembly can be constructed to periodically filter the re-circulated chemical solution down to 1 micron or less.

The filtered re-circulated chemical solution is pulled by a pump **124**, which can be a magnetic drive pump. The pump pushes the chemical solution to a heater **126** that heats or re-heats the chemical solution to an optimum temperature for stripping the coating from the process part. In the preferred embodiment, the operating temperature of the chemical solution can range from 60° F to 230°F, with the upper temperature range being preferred for most painted coatings.

From the foregoing description, it should be clear that the present invention contemplates combining a heated dip tank with a jet spray capability. The chemical solution is adapted to strip the coating from the underlying part, such as by disrupting the affinity of the coating for the part or breaking up any chemical or mechanical adhesion of the coating to the underlying part. The chemical solution can be a solution known in the art for removing paint from plastic parts, such as methylene chloride. However, the dangerous and regulated nature of this chemical makes it less acceptable for use in the present invention. Instead, the features of the present invention permit the use of much less hazardous chemicals. For instance, in certain preferred embodiments, the chemical solution can be a 40% solution of sodium hydroxide, or a 60% solution of glycolic acid. In other applications of the present invention, the chemical solution can include N-methyl pyrrolidone, 2-butoxyethanol, isopropyl alcohol, dibasic esters, or ethyl lactate, as well as other reagents, surfactants and reactants suitable to remove paint from a plastic surface.

The dip chamber **11** of the process tank **10** can be filled through the open top of the tank; however, the most preferred approach is to feed the solution through the fluid inlet **104**. While the tank is being filled, the lid **12** is opened and the process tank is de-activated, meaning that the various pumps and heaters are de-energized. The process chemical can be pumped from a separate source through the inlet **104** until the tank is filled. Since the circulation pump **124** is not activated, the fluid level within the tank will increase until the level reaches the vent tubes **28**. Preferably, the chemical level is directly observed with the lid **12** open. Once the dip chamber **11** has been filled, the separate source and pump can be disconnected and the fluid inlet **104** can be connected to a process chemical source.

When the tank is full, the circulation pump **124** and heater **126** can then be activated to pre-heat the process chemical solution prior to introduction of the process parts. The spray nozzles **32** do not need to be activated at this time. Once the chemical solution is up to temperature, the components can be de-activated so that the process parts can be immersed within the chemical bath.

Preferably, the parts are carried on dip racks, while the dip racks are preferably conveyed and supported by an overhead conveyor or crane. Once the dip racks are lowered into the dip chamber **11**, the overhead conveyor is disconnected so that the lid **12** can be closed over the process tank. At this time, the systems are re-activated so that the chemical solution circulates through the inlets **24** and the nozzles **32** spray an aerated jet of chemical solution onto the process parts. The duration of the process depends upon the nature of the coating to be removed and the characteristics of the underlying plastic part. Where the process part is of a high density plastic and the coating is a low tenacity coating, the process may last only a few seconds. In this circumstance, the temperature and flow rate of the re-circulated chemical solution can be at a maximum. In addition, the spray velocity through the nozzles can be at a maximum, since the underlying plastic part can withstand greater impingement forces from the air bubbles within the aerated jet chemical solution. On the other hand, where the part material is a low density plastic and the coating is a particularly tenacious paint, much longer process durations may be necessary, on the order of a number of days. In this circumstance, lower temperatures, flow rates and spray velocities can be required to prevent damage to the underlying plastic part.

The present invention provides a highly efficient system for stripping coatings from parts that are susceptible to pitting and other defects using traditional stripping processes. In the most preferred use, the parts are plastic, although parts formed of other materials can benefit from the system and method of the present invention. The present system can be implemented in a high volume production facility using a plant layout like that shown in **FIG. 12**. The facility **130** includes a staging area **132** where the incoming parts are stored in anticipation of processing. The products can be loaded at area **134** onto dip racks that are suspended from an overhead conveyor **136** or that can be engaged and lifted by an overhead crane. A number of process tanks **10** can be provided into which a fully loaded dip rack can be placed. Once the stripping process is completed, the overhead conveyor **136** can re-engage the dip rack to lift the rack from each process tank and transfer the rack to a cool down area

138. Prior to moving to the cool down area, the parts on the dip rack can be carried to a water rinse tank **140** to remove all remaining chemical solution from the parts. It is contemplated that anytime the lid **12** of a dip tank **10** is open, the components of the tank are shut down. In addition, when a dip rack is removed from a tank, it is held suspended above the tank for a period of time sufficient for all the chemical solution to drain off the processed parts. When the parts are cool enough to handle, the racks can be conveyed by the overhead conveyor **136** to an inspection area **142**. Parts that fail inspection because some coating remains can be sent back through the process.

The present invention contemplates an alternative process tank, such as the tank **150** shown in **FIG. 13**. This tank can be similar in construction to the tank **10** of **FIG. 1**, except that the nozzles **32** have been replaced by agitators **156**. In the illustrated embodiment, the agitators are mounted to the underside of the lid **154** and are operable to agitate the process chemicals within the chamber **152**. The agitators can be in the form of multi-bladed impellers that are rotated at a high rate to form vortices. The vortices increase the flow rate of the chemical solution impinging the process parts. As an alternative, the impeller blades can include apertures through which air can be fed so that the resulting air bubbles in the vortices provide an abrasive effect similar to the jet spray of the nozzles **32** in the prior embodiment.

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and described in the following written specification. It is understood that no limitation to the scope of the invention is thereby intended. It is further understood that the present invention includes any alterations and modifications to the illustrated embodiments and includes further applications of the principles of the invention as would normally occur to one skilled in the art to which this invention pertains.

Preferably, the chemical solution within the dip chamber **11** is the same solution that is injected through the spray nozzles **32**. However, in an alternative

embodiment, the chemical solution sprayed through the nozzles can be different from the chemical bath within the dip chamber. The difference in chemical solution can be in the form of a different concentration of the same constituent chemicals, or can constitute a different chemical formulation, provided that the different spray formulation does not react adversely with the chemical bath formulation.

As a further alternative, the spray chemical solution can include entrained particles, preferably small micron particles, which can be effective to "shot blast" the coating without damaging the underlying part. For instance, the particles can be micro-sized plastic pellets that can help disrupt the coating when sprayed at sufficient velocity through the chemical bath.